WHAT IS CLAIMED IS:

1. A pattern matching method for performing template matching on a waveform of a signal, a value of the signal varying according to at least a parameter, the pattern matching method comprising:

a first step of estimating an occurrence probability distribution of signal values at respective values of the parameter based on a plurality of measured signal waveforms;

a second step of generating a waveform template including an expected value of signal value at each value of the parameter and a probability template including a piece of occurrence probability information of the expected value at each value of the parameter based on the occurrence probability distribution; and

a third step of performing template matching between a newly measured signal waveform and the waveform template by using the piece of occurrence probability information of each of the expected values, which compose the probability template, as a piece of weight information at each value of the parameter.

2. The pattern matching method according to claim 1, wherein the occurrence probability distribution is a normal distribution.

3. The pattern matching method according to claim 1, wherein each of the expected values is an average value

of signal values measured at each value of the parameter, and wherein each piece of the occurrence probability information is in accord with a probability density function value, for the respective expected value, of the occurrence probability distribution.

4. The pattern matching method according to claim 1, further comprising:

a fourth step in which a new waveform template including a new, expected value of a signal value at each value of the parameter and a new probability template including a piece of occurrence probability information of the new, expected value at each value of the parameter are generated based on the new signal waveform and the occurrence probability distribution; and

wherein the fourth step and the third step are repeated sequentially.

5. A pattern matching method of performing template matching between a waveform template generated base on a plurality of measured signal waveforms and a subsequently measured signal waveform, comprising:

a first step of performing template matching between the template and a newly measured waveform; and

a second step of generating a new waveform template based on a plurality of waveforms further including the new signal waveform; and

wherein the first step and the second step are repeated

sequentially.

6. The pattern matching method according to claim 5, wherein the second step comprises:

a third step of estimating an occurrence probability distribution of signal values at respective values of a parameter based on the plurality of waveforms, the parameter relating to changes of a waveform; and

a fourth step in which a waveform template including an expected value of a signal value at each value of the parameter and a probability template including a piece of occurrence probability information of the expected value at each value of the parameter are generated based on the occurrence probability distribution.

7. The pattern matching method according to claim 6, wherein the occurrence probability distribution is a normal distribution.

8. The pattern matching method according to claim 6, wherein each of the expected values is an average value of signal values measured at each value of the parameter, and wherein each piece of the occurrence probability information is in accord with a probability density function value, for the respective expected value, of the occurrence probability distribution.

9. A pattern matching unit that performs template

matching on a waveform of a signal, a value of the signal varying according to value change of at least a parameter, the pattern matching unit comprising:

a template generator which generates a waveform template including an expected value of a signal value at each value of the parameter and a probability template including a piece of occurrence probability information of the expected value at each value of the parameter based on the occurrence probability distribution of signal values for the respective values of the parameter, the distribution being estimated from a plurality of measured signal waveforms; and

a matching judgment unit which performs template matching between a newly measured signal waveform and the waveform template by using pieces of occurrence probability information of the expected values as pieces of weight information at respective values of the parameter, the pieces of occurrence probability information composing the probability template.

10. The pattern matching unit according to claim 9,

wherein the template generator generates a new waveform template and a new probability template based on the new signal waveform and the occurrence probability distribution.

11. A pattern matching unit that performs template matching, comprising:

a template generator which generates a waveform template based on a plurality of measured signal waveforms; and

a matching judgment unit which performs template matching between a newly measured signal waveform and the waveform template; and

wherein the template generator generates a new waveform template based on the plurality of signal waveforms and the new signal waveform.

12. A position detection method of detecting a position of a specific mark formed on a detected body, comprising:

a first measurement step of measuring a plurality of marks having almost the same shape as the specific mark, the marks being formed on the detected body;

a second measurement step of measuring the specific mark;

a pattern matching step of performing pattern matching through use of a pattern matching method according to any of the claims 1 to 8, the pattern matching method using signal waveforms measured at the plurality of marks as a plurality of signal waveforms, a signal waveform measured at the specific mark as a new signal waveform, and positions as values of a parameter; and

a position detection step of obtaining positional information of the specific mark, based on the pattern

matching results.

13. The position detection method according to claim 12, wherein the specific mark changes periodically in a first direction, and wherein values of the parameter are positions in the first direction.

14. The position detection method according to claim 13, wherein the specific mark also changes periodically in a second direction that is different from the first direction, and wherein the parameter represents a two-dimensional position in a plane defined by the first and second directions.

15. A positional detector that detects a position of a specific mark formed on a detected body, comprising:

a measurement unit measuring the specific mark and a plurality of marks having almost the same shape as the specific mark, the marks being formed on the detected body;

a pattern matching unit according to any of the claims 9 to 11, performing pattern matching by using signal waveforms measured at the plurality of marks as a plurality of signal waveforms, a signal waveform measured at the specific mark as a new signal waveform, and positions as values of a parameter; and

a processing unit of obtaining positional information of the specific mark, based on the pattern

matching results.

16. The positional detector according to claim 15, wherein the measurement unit comprises a picking-up unit to pick up marks formed on the detected body, and the signal waveform is composed of changes, between positions, of a light intensity in a mark image picked up by the picking-up unit.

17. A alignment method of aligning a detected body on which a first number of marks having almost the same shape as one another are formed, comprising:

a mark position detection step of detecting positional information of a second number of marks through use of a position detection method according to claim 12, by sequentially using as a specific mark each of the second number of marks selected from the first number of marks; and

a alignment step of aligning the detected body, based on the positional information of the second number of marks detected in the mark position detection step.

18. A alignment unit that aligns a detected body on which a first number of marks having almost the same shape as one another are formed, comprising:

a position detector according to claim 15, detecting positional information of a second number of marks by sequentially using as a specific mark each of

the second number of marks selected from the first number of marks; and

a position controller to align the detected body, based on the positional information of the second number of marks detected in the position detector.

19. A exposure method of transferring a pattern formed on a mask onto divided areas on a substrate, comprising:

a divided area position detection step in which positional information of the divided areas on the substrate is obtained by detecting positional information, relative to the substrate, of a second number of alignment marks through use of a position detection method according to claim 12 while sequentially using as a specific mark each of the second number of alignment marks selected from a first number of alignment marks that are formed on the substrate as a detected body and have almost the same shape as one another; and

a transferring step of transferring the pattern onto the divided areas while aligning the substrate based on the positional information of the divided areas on the substrate obtained in the divided area position detection step.

20. The exposure method according to claim 19, wherein the plurality of divided areas are arranged in a matrix-shape on the substrate, wherein the alignment mark

comprises a third number of a first alignment marks having almost the same shape as one another and a fourth number of a second alignment marks having almost the same shape as one another, the first and second alignment marks being used respectively for aligning in row direction of the matrix and for aligning in column direction of the matrix,

wherein in the divided area position detection step, positional information, in the row direction on the substrate, of a fifth number of first alignment marks is obtained through use of a position detection method according to claim 12 while sequentially using as a specific mark each of the fifth number of first alignment marks selected from the third number of first alignment marks, and also positional information, in the column direction on the substrate, of a sixth number of second alignment marks is obtained through use of a position detection method according to claim 12 while sequentially using as a specific mark each of the sixth number of second alignment marks selected from the fourth number of second alignment marks, and wherein positional information, relative to the substrate, of the divided areas is obtained by statistically processing the positional information in the row direction of the fifth number of first alignment marks and the positional information in the column direction of the sixth number of second alignment marks.

21. An exposure apparatus for transferring a pattern formed on a mask onto divided areas on a substrate, comprising:

a stage unit moving the substrate along a predetermined plane; and

a position detector according to claim 15, obtaining positional information of a second number of positional marks by sequentially using as a specific mark each of the second number of alignment marks selected from a first number of alignment marks that are formed on the substrate as a detected body and have almost the same shape as one another.

22. A device manufacturing method including a lithography process, wherein in the lithography process, a predetermined pattern is transferred onto divided areas on a substrate according to an exposure method as recited in claim 19.

23. A device manufactured through use of an exposure apparatus according to claim 21.

A B S T R A C T

A template generator (32) generates a waveform template including an expected value of a signal value at each value of a parameter and a probability template including a piece of occurrence probability information of the expected value at each value of the parameter, based on a plurality of measured signal waveforms, and a matching judgment unit (33) performs template matching between a newly measured signal waveform and the waveform template by using pieces of occurrence probability information of the expected values as pieces of weight information at respective values of the parameter, the pieces of occurrence probability information composing the probability template. Additionally, the template generator (32) updates the waveform template and probability template taking into account the newly measured signal waveform so as to prepare next pattern matching. In this way, the template matching on the signal waveform that varies according to the change of the parameter's value is performed with improved accuracy of matching.

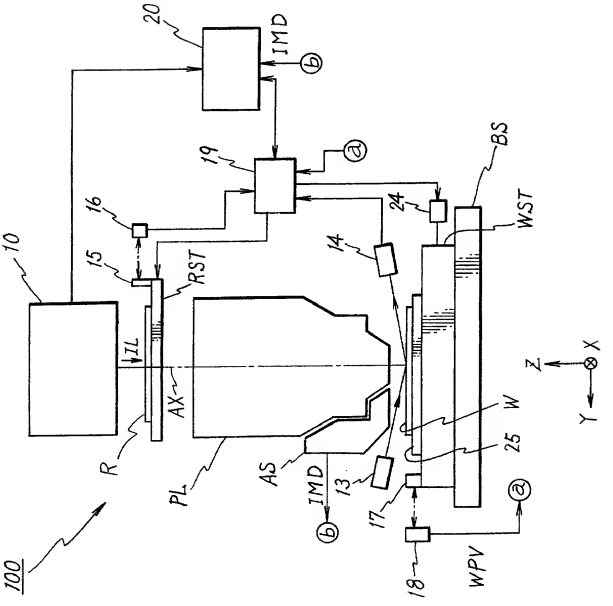
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Fig. 1